

REMARKS

By this Amendment, claims 17, 19, and 22 are amended. Claims 18 and 20-21 are canceled. No claims are added. Accordingly, after entry of this Amendment, claims 17, 19, and 22-31 will remain pending.

In the Office Action dated July 21, 2006, the Examiner rejected claims 17, 18-20, 23-25, and 28-31 under 35 U.S.C. § 102(b) as being anticipated by Buchanan et al. (U.S. Patent No. 6,245,616). Claim 21 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Buchanan et al. in view of Hattangady et al. (U.S. Patent No. 6,716,695). In addition, claims 22 and 26-27 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Buchanan et al. in view of Ballantine et al. (U.S. Patent No. 6,444,592). The Applicant respectfully disagrees with each of these rejections and, therefore, respectfully traverses the same.

Claims 17, 19, and 22-31 are patentably distinguishable over the references cited by the Examiner because they recite a method of forming a semiconductor microstructure that combines several features including, among them, positioning a substrate containing an initial dielectric layer in a process chamber, the initial dielectric layer being at least one selected from a group consisting of a first oxide layer and a high-k layer, flowing an oxygen-containing gas in the process chamber, and forming a second oxide layer between the initial dielectric layer and the substrate in a self-limiting oxidation process. None of the references describe or suggest this combination of features. Accordingly, the Applicant respectfully submits that the references cannot anticipate or render obvious any of claims 17, 19, and 22-31. As a result, the Applicant respectfully requests that the Examiner withdraw the rejections of the claims and pass this application quickly to issuance.

Buchanan et al. describes a method of forming an oxynitride gate dielectric and a pure silicon dioxide layer between the oxynitride layer and the silicon substrate. (Buchanan et al. at col. 4, lines 33-39.) The oxynitride layer 22 may be formed by passing at least one gas that contains nitrogen and/or oxygen over the surface of a silicon substrate. (Buchanan et al. at col. 4, lines 39-43.) The gas may be NO, N₂O, NH₃, or O₂ with a pressure between 1 mTorr and about 20 atm. (Buchanan et al. at col. 4, lines 43-50.) The oxynitride layer may, or may not, have other components such as a substantially pure SiO₂ layer 26 on top of the oxynitride layer 22. (Buchanan et al. at col. 6, lines 24-27.) After the oxynitride layer 22 is formed, the silicon substrate 12 is re-oxidized at an elevated temperature in an ambient containing an oxidizing and a halogenated species. (Buchanan et al. at col. 6, lines 28-31.) The oxidizing

agent, which may be O₂ or N₂O, diffuses through the oxynitride layer 22 to create an oxide spacer layer 32 underneath the oxynitride layer 22. (Buchanan et al. at col. 6, lines 31-33.) The halogenated species, which may be HCl, CH₂Cl₂, C₂H₃Cl₃, C₂H₂Cl₂, CH₃Cl, and CHCl₃, simultaneously acts to reduce the nitrogen content in the oxynitride layer 22, thus allowing a controlled nitrogen profile. (Buchanan et al. at col. 6, lines 34-38.) Buchanan et al. discusses that the re-oxidation process can be carried out as a thermal process in which an oxidizing halogenated atmosphere is provided at a pressure between 1 mTorr and about 20 atm, and at a temperature between about 500°C and about 1200°C. (Buchanan et al. at col. 6, lines 39-43.)

As is apparent from Buchanan et al., the method first involves the formation of an oxynitride layer 22 on the silicon substrate 12. Next, the substrate 12 and the oxynitride layer 22 are subjected to a re-oxidation process to form a substantially pure SiO₂ layer 32 between the oxynitride layer 22 and the silicon substrate 12. There is nothing in Buchanan et al. that describes a method including positioning a substrate containing an initial dielectric layer in a process chamber, the initial dielectric being at least one selected from a group consisting of a first oxide layer and a high-k layer, flowing an oxygen-containing gas in the process chamber, and forming a second oxide layer with high thickness uniformity between the initial dielectric layer and the substrate in a self-limiting oxidation process. Since Buchanan et al. does not describe each and every element recited by claims 17, 19, and 22-31, it cannot anticipate any of claims 17, 19, and 22-31. Accordingly, the Applicant respectfully requests that the Examiner withdraw the rejection under 35 U.S.C. § 102(b) with respect to claims 17, 19, 23-25, and 28-31.

Since claim 21 has been canceled, the Applicant respectfully submits that the rejection of claim 21 via the combination of Buchanan et al. and Hattangady et al. has been rendered moot. Accordingly, the Applicant does not address the rejection further herein.

Ballantine et al. describes an interfacial oxidation process for high-k dielectric process integration. Specifically, Ballantine et al. describes a method of fabricating an ultra-thin interfacial oxide, oxynitride, and/or nitride layer that can be utilized between active device regions present in a semiconductor substrate. (Ballantine et al. at col. 2, lines 20-23.) According to Ballantine et al., a semiconductor substrate 10 is employed that includes an active region 12 in which electrons are allowed to flow freely. (Ballantine et al. at col. 3, lines 50-51.) An ultra-thin interfacial oxide, oxynitride, and/or nitride layer 14 is formed on the substrate 10. (Ballantine et al. at col. 3, lines 59-62.) A high-k dielectric material 16 is

thereafter formed on the ultra-thin oxide, oxynitride, and/or nitride layer 14. (Ballantine et al. at col. 4, lines 12-20.) The ultra-thin interfacial oxide, oxynitride, and/or nitride layer 14 may be formed using a rapid thermal oxidation (RTO), oxynitridation (RTON), or nitridation (RTN) process carried out in an oxidizing ambient such as oxygen, NO, N₂O, NH₃, and other like ambients. (Ballantine et al. at col. 5, lines 9-13.) Typical pressure ranges for the gases are from about 10 to about 1000 Torr. (Ballantine et al. at col. 5, lines 34-36.)

As is immediately apparent, the oxide, oxynitride, or nitride layer 14 is deposited on the substrate 10, followed by formation of the high-k dielectric layer 16. This is in dramatic contrast to the teachings of the present invention. Accordingly, the Applicant respectfully submits that Ballantine et al. does not cure the deficiencies noted with respect to Buchanan et al. and, therefore, cannot be combined with Buchanan et al. to render obvious any of claims 22 or 26-27. At least for this reason, the Applicant respectfully submits that the rejection of claims 22 and 26-27 should be withdrawn in favor of an allowance of the claims.

All objections and rejections having been addressed, it is respectfully submitted that the present application is in a condition for allowance and a Notice to that effect is earnestly solicited.

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Respectfully Submitted,

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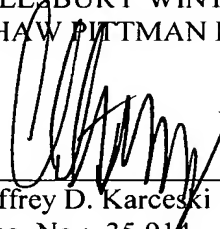
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